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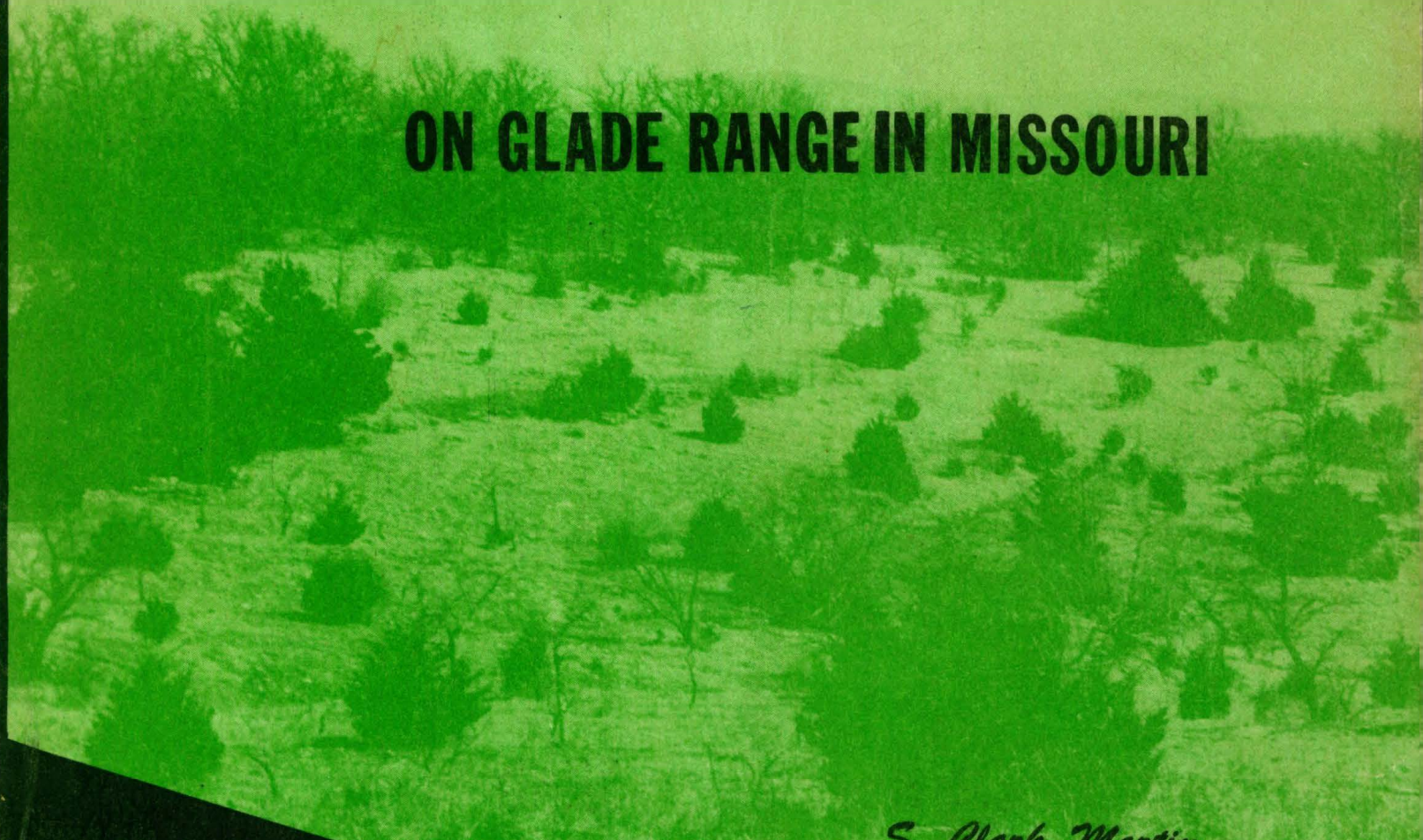
BURNING AND GRAZING ON GLADE RANGE IN MISSOURI



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CENTRAL STATES
FOREST EXPERIMENT STATION

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"THE GLADES"

The "glades" or "balds" occupy about 500,000 acres in the White River watershed in southwestern Missouri and northwestern Arkansas. Topography is rough and soil conditions extremely variable. The glade soils are very thin and are usually underlain by horizontal ledges of limestone that give the grassy, treeless, hillsides a terraced appearance. But even where the glades are most extensive, the open grassland is intermingled with stands of timber.

Except for redcedar, the glades will not grow commercial timber and they are not suitable for improved pasture. Perennial vegetation consists mainly of prairie grasses, including little bluestem (Andropogon scoparius Michx.), big bluestem (A. furcatus Muhl.), purpletop (Triodia flava (L.) Smyth.), switchgrass (Panicum virgatum L.), Indiangrass (Sorghastrum nutans (L.) Nash.), prairie dropseed (Sporobolus heterolepis A. Gray.), and side-oats gramma (Bouteloua curtipendula (Michx.) Torr.). Where grazing has been heavy, especially where the soil is thin, the perennial grasses have been largely replaced by annuals which are collectively referred to as "bald" grass. Some of the glades have been invaded by redcedar so dense that the forage is almost gone. However, with good range management, including effective woody-plant control, they will provide a stable source of range forage and probably will remain in grass indefinitely.


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BURNING AND GRAZING

ON GLADE RANGE IN MISSOURI

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The carrying capacities of many glade range areas in Missouri are being reduced by the spread of eastern redcedar (Juniperus virginiana L.). To affected stockmen, this increase in redcedar means decreased income from grazing. How can the range cattleman keep redcedar from reducing his range income?

Periodic burning to control brush is a common Ozark practice. On most Ozark ranges, fire controls brush only temporarily because the "brush" consists mainly of hardwoods that sprout from the base if the tops are killed by fire. On such ranges, fires seldom "kill" either big trees or little trees but, if repeated often enough, they do keep the little trees from getting big.

The "glades" are not like most Ozark forest range, however. The soils are different, the plants are different -- and the fires and their effects are different. Glade soils are so thin that the common Ozark hardwoods seldom grow on them. Consequently, that fire damages valuable hardwood timber is not a valid argument against burning the glades themselves, although precautions must always be taken to keep the fire from spreading to intermingled forest land. Most of the glades are covered with grass instead of trees; so fires on the glades are sustained mainly by dry grass rather than by hardwood litter.

The most aggressive woody invader of glade range is not a hardwood but eastern redcedar. Unlike the common Ozark hardwoods, eastern redcedar does not sprout from the base if the top is killed and the tops are relatively easy to kill by burning. So the absence of valuable hardwoods and the susceptibility of redcedar to fire suggest that burning might be a useful tool on glade range.

TEST BURN MADE

Since stockmen are concerned about the spread of redcedar on both public and private land, a test burn was made in 1952 in cooperation with the Mark Twain National Forest to determine the effects of fire and subsequent grazing on redcedar, little bluestem, and on the amount of bare soil on glade range. To be considered successful the burn would have to greatly reduce the amount of live redcedar without seriously reducing the density of the grass or increasing the amount of bare soil.

Small burned spots of range often attract so many cattle that the effects of fire and overgrazing are combined in a way that is very detrimental to the grass (fig. 1). Obviously, burning cannot be a part of good range management unless the range is managed to prevent overgrazing after the fire. One way to avoid such overgrazing might be to burn enough area to support the grazing herd adequately without overgrazing. So a large area was burned rather than a small plot.

The study area is a 300-acre tract of typical glade range in Taney County, in southwestern Missouri. The "glades" are grassy, almost treeless slopes or ridges sometimes referred to as "balds." The glades here are not continuous but are interrupted by patches of scrubby hardwood timber that occur where the soil is relatively thick. In the glade region, the thicker soil is found on the lower slopes and on the highest ridgetops. Timber stands are composed mostly of post oak (Quercus stellata Wangenh.), black oak (Q. velutina Lam.), and associated species.

The glades proper occur on land that has thin, stony soil and frequent horizontal outcrops of limestone and usually occupy the lower ridges and intermediate slopes. Glade soils cannot hold enough water to grow the common Ozark hardwoods and are able to support a grass cover only because of the relatively high precipitation (40 inches per year). Little bluestem is the most abundant perennial grass. Where the soil is especially thin, the grass cover is composed mainly of annuals (mostly Sporobolus neglectus Nash. and S. vaginiflorus (Torr.) Wood.) which are known collectively as "bald" grass.

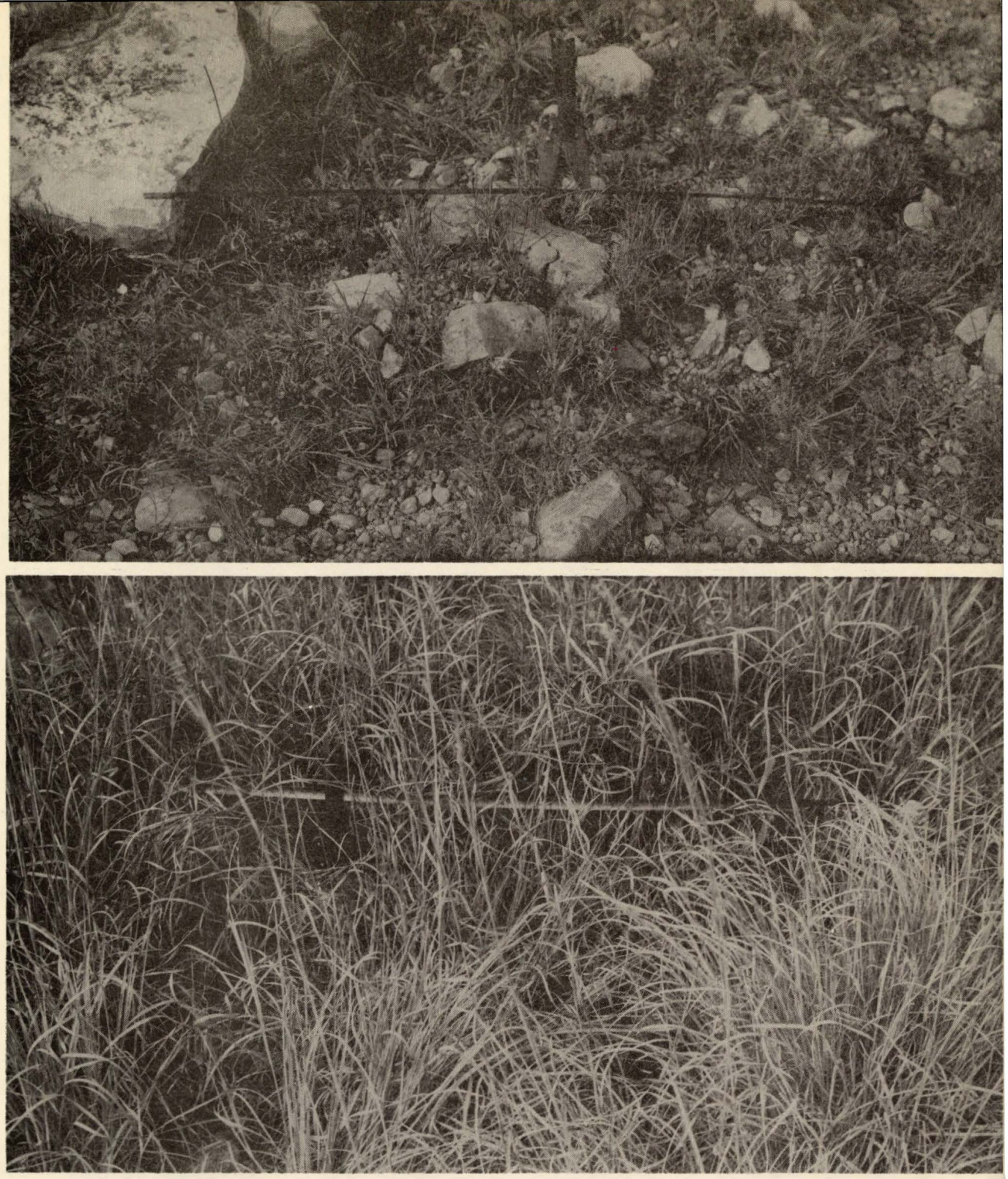

Figure 1.--Small burned areas are usually overgrazed. Area above was accidentally burned during the winter of 1949-50 and was severely overgrazed during the 1950 growing season. Area below was not burned and was scarcely touched by cattle even though no fence or other livestock barrier separates the two adjacent spots. Both pictures were taken in October 1950.

CONDITIONS AND METHODS OF STUDY

The study area is about equally divided between glade grassland sprinkled with eastern redcedar and scrubby hardwoods, and dense patches of hardwoods dominated by post oak (fig. 2). Annual and perennial grasses are the principal "fuels" in the openings; hardwood litter is the principal fuel in the post oak patches. Both types of fuel burn readily during dry periods, especially in winter when hardwood litter is abundant and grasses are dormant.

For the 3 years before this study was begun, precipitation and herbage yields were greater than normal, causing an accumulation of herbage on the little-used portions of the glades. However, grazing during the winter immediately preceding the burn severely reduced the volume of herbage in natural stock-concentration areas.

Dry weights of grass herbage from plots clipped on March 7, 1952, ranged from 916 to 5,020 pounds per acre on light to heavy stands of bluestem and averaged about 2,000 pounds per acre. Most of the herbage was less than 16 inches tall but was sufficiently continuous, together with the hardwood litter, to permit a relatively clean burn.

The test burn was followed by 3 years of severe drought with consequent low herbage yields. The number of stock using the area remained about the same but grazing was limited to the May-December grazing season. Reduced herbage production, without equivalent reduction in livestock numbers, led to widespread close grazing.

BURNING CONDITIONS

Cool temperatures and light northeast winds prevailed over the 5-day period ending March 7, the day of the burn. A minimum temperature of 13 degrees and a maximum temperature of 60 degrees were recorded on the study area during the period. Rainfall at Hercules Tower (4 miles west of the study area) amounted to 1.08 inches on May 3 and 4. Minimum relative humidities were in the high twenties each day after the last rain on May 4.

Temperature at the study area on the day of the burn ranged from 28 to 60 degrees; the lowest relative humidity was 26 percent; and the sky was clear. Wind from the southeast averaged 4.7 miles per hour during the period of the burn.

Samples of annual and perennial grasses were collected for moisture content determinations between 2:00 p.m. and 3:15 p.m. as the fire was getting started. The mean moisture content of 22 samples was 7.45 percent of ovendry weight, with a standard deviation of 1.22 percent. Grasses on the east slope contained about 1 percent more moisture than did grasses on the west slope.

The soil was wet, seeps were muddy, and water flowed in all the drainages. The well-dried fuel on wet soil permitted a clean burn of grass and surface oak leaves with comparatively little immediate loss to the small supply of humus.

Figure 2.--Typical glade range in early spring after 3 years of drought and close grazing. Notice the relatively open intermediate slopes and the stands of hardwoods on the ridges and along the stream bottoms and lower slopes. The conspicuous evergreens are eastern redcedar.

STOCKING OF REDCEDAR

A tally of 30 plots of 0.045 acre each showed an average of 581 redcedars per acre. Four-fifths of the trees were less than 5 feet tall and more than nine-tenths were less than 7 feet tall (table 1). Most of the redcedar seedlings were found under or near trees or bushes. Some were under or near the crowns of parent cedars; others occurred in groups beneath the crowns of persimmon (Diospyros virginiana L.), winged elm (Ulmus alata Michx.), and smoketree (Cotinus obovatus Raf.) which is called "yellow wood" locally. The tendency for redcedar to occur in clumps throughout the area is partly because redcedar seed is commonly distributed in bird droppings.

Table 1.--Number and percent of redcedar trees per acre by height classes

Height of trees in feet	Number	Percent
0.5	194	33
1	82	14
2	76	13
3	73	13
4	44	8
5	34	6
6	32	6
7	14	2
8	12	2
9+	20	3
Total	581	100

EFFECTS OF FIRE ON REDCEDAR

The effect of the fire on eastern redcedar was determined from 200 sample trees: one group of 100 trees was located on a west slope and one group of 100 on an east slope. The trees were selected prior to the fire and information gathered on the height, width of crown, density of crown, height of green crown above the ground, fuel under and around the tree, and butt diameter of stem. Examinations were made 1 month, 7 months, and 12 months after the fire to determine the number of dead trees and the amount of scorched crown in the live trees.

A few small unburned islands were found after the fire. These occurred where the herbaceous cover was very light such as overgrazed wet spots or beneath large, low crowns of cedar and spots where the fire was stopped by bare rock outcrops. Almost all of the very small cedars that survived the fire were found on these unburned areas.

Mortality of eastern redcedar was greatest on the small trees and least on the large trees; the fire killed nearly all trees up to 1.5 feet tall but very few of those taller than 6.5 feet (fig. 3). Results were essentially the same on the east and west slopes.

Some of the reasons why fire failed to kill large trees are fairly simple. It was observed that cedar crowns stopped burning almost as soon as the surface fuel burned out. Although the light, grass fuels burn out quickly, providing a very short period of intense heat, the foliage of most of the small trees was completely consumed. Most of the medium-sized trees that were killed died as a result of a combination of burning and scorching. The crowns of large trees suffered only a little burning or scorching damage near the ground. Apparently it is necessary either to burn or scorch all of the foliage on a tree in order to kill it.

Whether or not a cedar tree was killed depended chiefly on the ratio of the amount of surface fuel to the amount of redcedar foliage to be consumed. This ratio was affected both by the size of the tree and the density of the crown. In general, the larger the tree and the more trees per clump the less grass there was beneath the crown. But, more fuel is required to burn a large tree or a clump of trees than is required to burn a single small one. Similarly, trees with dense crowns were harder to kill than trees with light crowns. Mortalities for redcedar trees with very light, light, moderate, and heavy crowns were 90, 82, 66, and 35 percent, respectively. It is assumed that tall trees and dense-crowned trees are both hard to kill because they have a lot of cedar foliage to burn but not much grass under them to burn it. On the other hand, small or thin-crowned trees have only a little cedar foliage but a lot of grass under them.

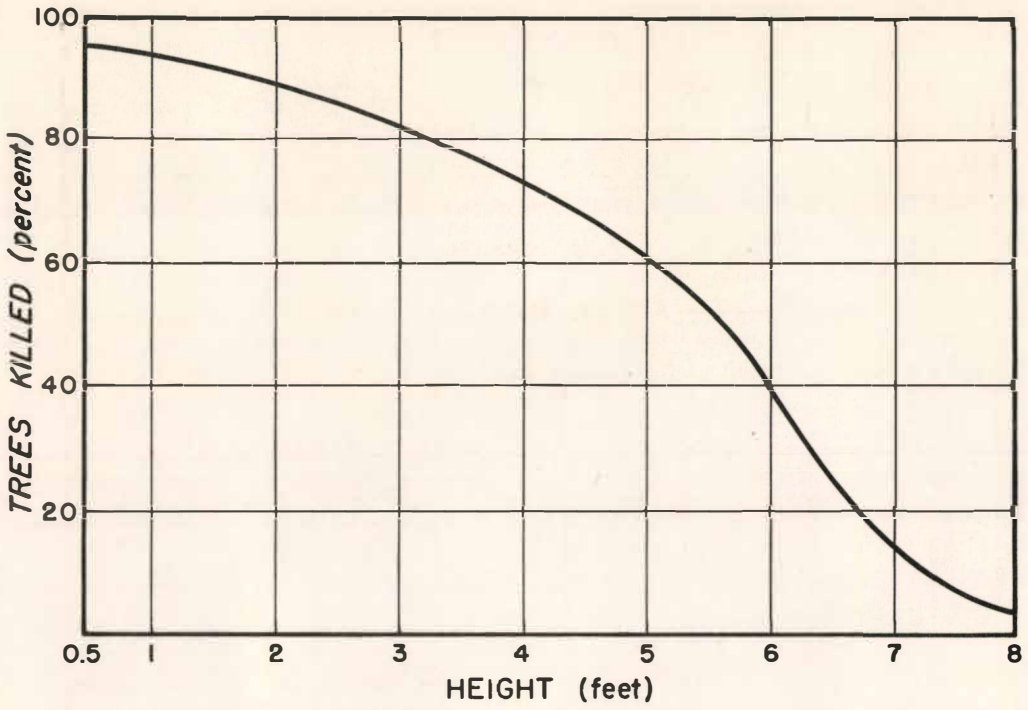

Figure 3.--Percent of eastern redcedar trees fire killed, by height classes.

From a stockman's viewpoint, how much cedar control was accomplished by burning? The fire killed almost all of the very small trees but only a few of the large ones (fig. 4). If it is assumed that each redcedar tree occupies a circular area whose diameter is equal to the tree height, about 12 percent of the area was occupied by redcedar before the burn. Fire reduced this figure to about 7 percent, indicating the release of about 5 percent of the study area from redcedar competition. However, the amount of area released from redcedar now is only part of the cedar-control story. An 8-foot tree occupies more than 60 times as much area as does a 1-foot tree. And, almost every 1-foot live tree is potentially an 8-footer, 10 or 15 years hence. So, every 1-foot tree killed by fire now saves chopping an 8-footer in 1965 or 1970. In the meantime the growing space that would otherwise be used by the tree will be available for forage production. The value of burning for redcedar control may lie not so much in the area released for immediate forage production as in the amount of area that will be available for growing forage 10 or 20 years from now.

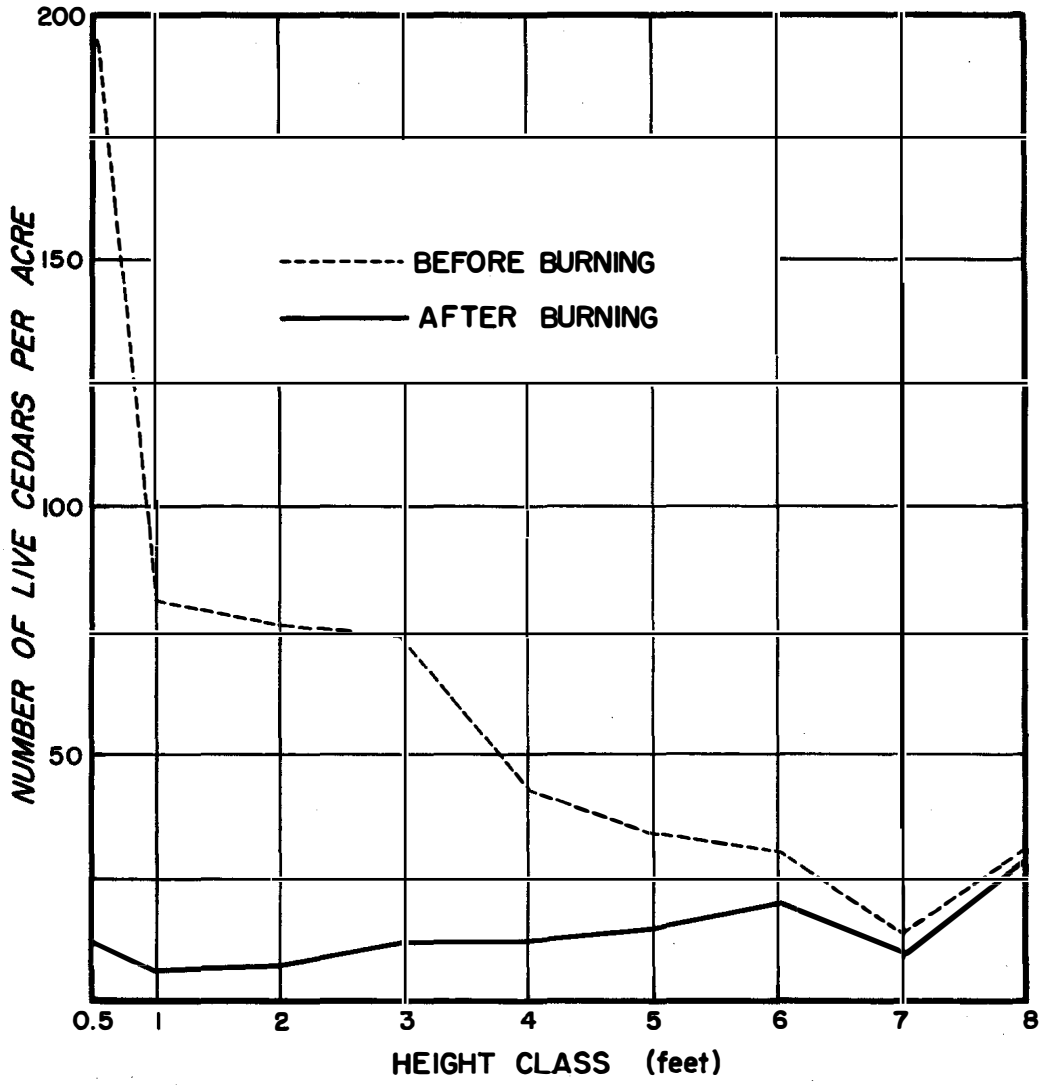

Figure 4.--Approximate number of live redcedar trees per acre before and after burning.

EFFECTS OF FIRE ON HERBACEOUS VEGETATION AND SOIL COVER

The combined effects of fire, drought, and grazing on the forage were determined from frequency data taken on 25 permanent transects. The presence of given species or classes of plants was recorded within a frame 0.66 feet square at each odd-numbered foot mark along a 50-foot tape. In addition, the amount of bare soil within each frame was estimated to the nearest 10 percent and the number of weed species on each frame was recorded. Transects were measured in the fall of 1952, 1953, and 1954. They were located on range that was grazed but not burned, on range that was burned but not grazed after burning, and on burned range that was grazed heavily after burning. Protection from grazing was provided by two cattle exclosures on the burned area. Grazing use during the 1952-54 period was consistently heavy on all areas where cattle were not excluded. Since the summers of 1952, 1953, and 1954 were extremely dry, the effects of fire are confounded with effects of drought and in some cases with effects of overgrazing.

The frequency of little bluestem declined under all three treatments. The decrease in frequency was about 15 percent for the grazed areas, 30 percent for the burned areas, and 75 percent for areas that were both burned and grazed. Almost all of the frequency loss on the areas that were either burned or grazed occurred between August 1952 and October 1953. Areas that were both burned and grazed lost almost as much little bluestem between October 1953 and October 1954 as they did between August 1952 and October 1953. These data indicate that under drought conditions either burning or close grazing will reduce the stand of little bluestem but that burning is the more detrimental influence of the two.

Frequency data for bald grass were inconclusive, but general observations indicate sharp decreases in abundance and volume of bald grass under all three treatments.

A very conspicuous increase in the abundance of such annual weeds as croton (Croton spp. L.), ragweed (Ambrosia artemisiifolia L.), and palafoxia (Palafoxia callosa (Nutt.) T. & G.), occurred on the study area and on glade range in general. In 1952 weeds occurred in 41 percent of the frames and the average number of species per frame was 0.54. In 1954 weeds occurred in 86 percent of the frames and the average number of species per frame was 1.67. Differences among treatments were relatively small. Apparently any combination of drought, fire, and grazing that reduces the grass cover is likely to increase the abundance of unpalatable annual weeds. Consequently, the increase in weeds on the study area cannot be attributed solely to the burning treatment.

In August 1952, 5 months after the burn, 75 percent of the soil area was bare on both grazed and ungrazed portions of the burned range. On the unburned area only 25 percent of the soil surface was exposed. By October 1952 the amount of bare soil had decreased to 56 percent on range that was burned only, and had increased to the same figure on range that was grazed only. Meanwhile, 72 percent of the soil was still bare on the range that was both burned and grazed.

What practical implications may be drawn from these observations on the effects of fire and grazing on herbaceous vegetation and the amount of exposed soil? The entire range had suffered from drought and subsequent overgrazing. Even burning a large area (300 acres) did not prevent overgrazing. If precipitation and forage production had been normal, perhaps grazing use on the burned area would not have been so heavy (fig. 5). While these apparent effects alone do not justify prohibiting burning unconditionally, they do provide a strong argument for stringent grazing control in connection with burning. Positive protection from overgrazing after burning is essential for the maintenance of the forage and the soil cover.

Figure 5.--Fire, followed by overgrazing, robs the soil of its protective cover. Here the entire area was burned over in March 1952. The area to the right of the fence was fenced in April 1952 to exclude cattle grazing.

GENERAL CONCLUSIONS

1. Of all the woody species that reduce forage production on Ozark forest ranges, eastern redcedar is the only one of importance that can be effectively controlled by burning. And, the "glades" are the only Ozark range type where controlling redcedar is the main woody-plant problem. On most Ozark ranges, the stockman needs to control a jungle of sprouts of such species as post oak, blackjack oak, hickory, persimmon, and winged elm which cannot be killed by fire.

2. The severe 3-year drought that followed the test burn undoubtedly exaggerated the detrimental effects of both fire and grazing. In fact, failure to adjust cattle numbers to the lower forage yields during the dry years was mainly responsible for the close grazing of the study area. In this study, burning followed by close grazing severely reduced the stand of little bluestem and greatly reduced the amount and quality of soil cover. The combined detrimental effects of burning and overgrazing were much more severe than for either burning or grazing alone.

3. Fire cannot be expected to do a complete job of redcedar control. In this study, fire killed only 7 percent of those trees that were more than 6.5 feet tall. These large, hard-to-kill trees are the ones that reduce current grass production most and are the most likely seed source for future redcedar infestations. However, the little trees killed by the fire will make a big difference in the relative amounts of cedar and grass 10 or 20 years from now. In other words, fire may be a reasonably effective tool for keeping the range in grass if used during the early stages of redcedar invasion, but it is not a good way to get the range back into grass after redcedar has taken possession.

4. Even the best burning job will require some follow-up. Since fire is most effective on small trees, for best results in cedar control burning must be repeated often enough to keep the fastest growing trees from getting too big to kill with the average fire. In this study about 9 percent of those trees up to 3.5 feet tall survived the fire, mainly by escaping it. Trees that escape the fire or are too large to be killed by it should be cut or killed with chemicals.

5. Fire is not necessarily a cheap tool for controlling redcedar. Effective burning can be done only if there is an adequate accumulation of herbage. A year of nonuse, or very light use, beforehand may be a part of the price of an effective burn.

After the burn, another period of light use or total rest is needed to allow forage plants to recover and to prevent excessive erosion. So -- burning may well cost at least two forage crops, one before and one after the burn. Since cattle tend to concentrate on freshly burned areas, the cost of a fence may also have to be included. If heavy grazing is permitted before the burn, the result probably will be an ineffective fire. If heavy grazing is permitted after the burn, the result probably will be a severe loss in grass density and soil cover. At best, there will be a period following the fire when the soil is severely exposed to erosion from heavy rains. On the thin soils of the glades, the loss of only a little topsoil may be too high a price to pay for dead cedar trees.

6. All alternate methods of control should be considered before deciding to burn. Chopping is just as effective as burning for killing redcedar and does not destroy forage or soil cover. Although cutting or possibly chemical control may require more work, it seems likely that the average Ozark stockman can better afford to systematically cut the cedar off a few acres each year than to take the chances involved in burning.

7. Burning cannot be recommended for redcedar control on glade range because of its destructive effects on the forage and soil cover. A further objection to burning is that without strict control of grazing it is nearly always followed by severe overgrazing. Fire will accomplish a degree of control on eastern redcedar but, burning for cedar control must be accompanied by proper care of the range. IF BURNING TO CONTROL EASTERN REDCEDAR IS TO DO MORE GOOD THAN HARM, GOOD GRAZING MANAGEMENT BOTH BEFORE AND AFTER BURNING IS A "MUST."

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